

What is claimed is:

- [c1] 1. An engine or other device having a Z-crank operated by axially arranged pistons and cylinders whose axes parallel the rotational axis of the Z-crank and where the motion converter is prevented from rotating as it nutates by means of:
- a) a reaction control shaft
 - b) the axis of rotation of which is parallel to the axis of rotation of the Z-crank
 - c) the reaction control shaft, having a cylindrical section parallel to and offset from its axis of rotation
 - d) so as to provide an eccentric bearing surface
 - e) for a bushing mounted to the motion converter
 - f) that rotates relative to the motion converter and slides and rotates relative to the reaction control shaft
 - g) where the reaction control shaft is driven by gears or other means to rotate at twice the Z-crank speed.
- [c2] 2. An engine or other device as described in Claim 1 where there are two complete sets of motion converters, connecting rods and pistons combined face-to-face and there is a double Z-crank.
- [c3] 3. An engine or other device as described in Claim 1 where there are two complete sets of motion converters, connecting rods and pistons combined back-to-back and there is a double Z-crank.
- [c4] 4. An engine or other device having a Z-crank operated by axially arranged pistons and cylinders whose axes parallel the rotational axis of the Z-crank and where the motion converter is prevented from rotating as it nutates by means of:
- a) a stationary gear coaxial to the axis of rotation of the Z-crank and fixed to the engine housing

- b) engaged with a planetary gear carried on the Z-crank
- c) the planetary gear and a third gear fixed together
- d) the third gear engaged with a fourth gear that is fixed to the motion converter
- e) the ratio between the planetary gear and the stationary gear is the same as the ratio between the third gear and the fourth gear.

- [c5] 5. An engine or other device as described in Claim 4 where there are two complete sets of motion converters, connecting rods and pistons combined face-to-face and there is a double Z-crank.
- [c6] 6. An engine or other device as described in Claim 4 where there are two complete sets of motion converters, connecting rods and pistons combined back-to-back and there is a double Z-crank.
- [c7] 7. An engine or other device having a Z-crank operated by axially arranged pistons and cylinders whose axes parallel the rotational axis of the Z-crank and where the Z-crank is provided with splines or other means at both ends to allow for axial movement of the Z-crank relative to its output connection and flywheel and its valve gear and accessory drive.
- [c8] 8. An engine or other device as described in Claim 7 where there are two complete sets of motion converters, connecting rods and pistons combined face-to-face and there is a double Z-crank.
- [c9] 9. An engine or other device as described in Claim 7 where there are two complete sets of motion converters, connecting rods and pistons combined back-to-back and there is a double Z-crank.
- [c10] 10. An engine or other device having a Z-crank operated by axially arranged pistons and cylinders whose axes parallel the rotational axis of the Z-crank and

where the compression ratio of the device is automatically varied during operation by means of:

- a) a mechanical actuator
- b) electronically controlled by an engine control unit
- c) that displaces the Z-crank and motion converter along its axis
- d) in response to variations in power demand, load and other conditions
- e) as input to the engine control unit from sensors.

[c11] 11. An engine or other device as described in Claim 10 where there are two complete sets of motion converters, connecting rods and pistons combined face-to-face and there is a double Z-crank.

[c12] 12. An engine or other device as described in Claim 10 where there are two complete sets of motion converters, connecting rods and pistons combined back-to-back and there is a double Z-crank.

[c13] 13. An engine or other device having a Z-crank operated by axially arranged pistons and cylinders whose axes parallel the rotational axis of the Z-crank and where the connecting rods are provided at one or both ends with split shell bearings having:

- a) a spherical surface on the inner surface of the bearing
- b) a cylindrical surface on the outer surface of the bearing
- c) a means for locating and fixing the bearing to the connecting rod
- d) auxiliary cylindrical bearing surfaces to engage trunnion pins and concentrically supporting a trunnion having:
 - a) a spherical outer surface
 - b) a cylindrical inner surface for interface to a wrist pin
 - c) cylindrical trunnion pins to prevent rotation of the connecting rod about its long axis.

- [c14] 14. An engine or other device having a Z-crank operated by axially arranged pistons and cylinders whose axes parallel the rotational axis of the Z-crank where:
- a) the piston and associated connecting rod are fixed together
 - b) the outside of the piston is tapered at one or both ends
 - c) the largest diameter section of the piston is spherical in shape and is slightly smaller in diameter than the cylinder into which it is fitted.
- [c15] 15. An engine or other device having a Z-crank operated by axially arranged pistons and cylinders whose axes parallel the rotational axis of the Z-crank where:
- a) the piston and associated connecting rod are combined into a single piece
 - b) the outside of the piston is tapered at one or both ends
 - c) the largest diameter section of the piston is spherical in shape and is slightly smaller in diameter than the cylinder into which it is fitted.